WRP Technical Note VN-RS-4.1
March 1997

Species Match Ensures Conversion of Wet Agricultural Fields to Bottomland Hardwood (BLH) Wetlands

PURPOSE: This technical note provides guidance for determining species composition when planning the reforestation of BLH wetland restoration sites.

BACKGROUND: BLH wetlands are recognized to perform wildlife, water quality, and recreation functions. Significant losses in acreage and the concomitant loss of functions have occurred primarily because of clearing and drainage for agriculture. Implementation of the 1985 Food Security Act has slowed the loss of BLH acreage, and federal programs such as the Wetlands Reserve Program have promoted the restoration of flood-prone agricultural land to BLH wetlands. Also, these wet fields provide an excellent option for the mitigation of impacts required by the Clean Water Act amendments.

During the planning of a BLH wetland restoration project, observing the regional natural interrelationship between hydrology, soils, and vegetation can serve as a useful guide toward selecting the desirable tree species and matching them to particular locations. However, agricultural land suitable for BLH wetland restoration may still have significant alterations in hydrology and soil physical properties. Soil grading and levees may have decreased or increased the depth and duration of flooding. A plow-pan may have formed, increasing the duration of soil saturation or flooding. Drainage channels could decrease the frequency, depth, and duration flooding in one area but, because of the enhanced water conveyance, could increase the frequency, depth, and duration of flooding in another area.

Consideration must also be given to changes in hydrology upstream or downstream within the watershed which can significantly influence onsite hydrology (for example, discharge from a reservoir upstream from the restoration site). Consequently, decisions regarding the location of various species may be more difficult. Familiarization with the location and type of hydrologic alterations may enhance the reforestation planner's options in locating desirable tree species. For example, cherrybark oak (*Ouercus pagoda* Raf.) is arguably the most desired bottomland hardwood species because of its wildlife and timber value. Areas where flooding and soil saturation have been reduced by drainage channels or levees may now support this weakly flood-tolerant species.

Knowledge of both the site characteristics and the ecological characteristics of the endemic BLH tree species is necessary when trying to successfully match species to a BLH wetland restoration site.

METHODS: Obtaining a thorough knowledge of the restoration site and the endemic tree species will require both office and field work.

OFFICE WORK: Of the three parameters that define a wetland (wetland hydrology, hydric soils, and hydrophytic vegetation), hydrology is the least understood and measured factor. A United States Geological Survey (USGS) 7.5-min quadrangle map will provide an idea of topography, water bodies and drainage patterns within the site. Also, acquiring quadrangle maps depicting lands adjacent to the restoration site may provide an idea of upstream and downstream hydrologic influences. Remember that the contours are usually mapped at only 10-ft (3-m) intervals. This is probably insufficient for making decisions on the location of microsite concave landforms (hollows, swales, etc.) which could on occasion

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **MAR 1997**	2. REPORT TYPE	3. DATES COVERED **-**
4. TITLE AND SUBTITLE **Species Match Ensures Conversion of Wet Agricultural Fields to Bottom[and Hardwood (BLH) Wetlands**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Army Engineer Waterways Experiment Station,3909 Halls Ferry Road,Vicksburg,MS,39180-6199**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT **see report**		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**		**6**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

exhibit flooding or soil saturation conditions. Ridge and swale topography where the relief is less than a few feet can have significant influences on the overall site hydrologic characteristics (for example, the Mississippi Delta). If the site is located near a large stream or river, the USGS or Corps of Engineers (CE) may have stream gauge data available. Combining gauge data with the topographic maps can provide an idea of the frequency, duration, timing, and location of flood events.

Aerial photographs can provide direct evidence for the time and location of flooding or soil saturation. The U.S. Agricultural Stabilization and Conservation Service (ASCS) photographs agricultural land yearly in order to monitor the compliance of federal programs, and may be a good source for aerial photos. The CE, the U.S. Fish and Wildlife Service, or private companies may also be a good source for aerial photography.

Topographic maps, stream gauge data, and aerial photos can provide information on surface water hydrology but provide little information on potential groundwater influences. Flooding or soil saturation within the root zone (within 20 in. (50 cm) of soil surface) caused by groundwater will influence tree species distribution in a similar fashion as surface water hydrology. Unfortunately, time will probably not permit a surficial groundwater monitoring effort using piezometers, and published data for the particular restoration site are probably not available. However, contacting the USGS, CE, or a local university may be helpful in acquiring any available information on groundwater.

Information on soils can best be obtained from a U.S. Soil Conservation Service (SCS) County Soil Survey. If available, a survey usually can be obtained from the SCS county field office. If copies are unavailable or the site has not been soil mapped, the SCS county field office will probably have information on the soil conditions.

A basic understanding of the regional ecology is recommended. Knowing how the local environment influences plant distribution and successional patterns can give the reforestation planner a mental picture of how newly created forest will progress over time. If restoring wildlife habitat is an objective, a better perception may be gained of animal habitat needs and animal use patterns. Published literature on the local ecology can sometimes be found in the "Local Interest" section of private bookstores. City, county, or university libraries may also be a good source for regional ecology literature. Do not hesitate to contact faculty members within the biology, botany, forestry, or agriculture departments at local colleges and universities. They may be of immense help in locating literature or answering direct questions regarding topics relative to the restoration project.

FIELD WORK: Ideally, completing all background data collection and review prior to a site visit will better organize the restoration planner's time in the field. This is especially important when the restoration project encompasses a large area. More valuable field time can be spent in problem areas indicated by the office review. In addition to all maps, aerial photos, and soils information, plan to take a small notebook, camera, and spade. Use the notebook to map special features or problem areas and to write general comments. Nothing you see or think about regarding the restoration effort should be considered frivolous. The camera will be used to photograph the general appearance of the landscape and potential problem areas. The spade will be used to verify published soils information by digging small soil pits for determination of soil texture, structure, and color. Dig the soil pits deep enough to include the root zone (at least 20 in. (50 cm) deep) in order to observe any growth obstructions such as a plow-pan or high water table. The notes and observations made should be readily transferable to a reforestation plan map. The map will include the field observations as well as the location of tree species to be planted.

It is strongly recommended that the site visit occur when the hydrologic influences are the greatest. For example, in the Mississippi Delta, potential BLH wetland restoration sites should be visited during the winter and early spring when flooding and soil saturation conditions are usually the most severe. Summertime visits would probably provide little evidence of the location, depth, and duration of flood events. If this is not possible, observing soil color can be of special significance with regard to presence of anaerobic conditions caused by flooding or soil saturation. If, within the root zone, the soil color is gleyed or the matrix chroma is low with or without bright mottles, the area may experience long-term flooding or soil-saturated conditions. Remember that the soil color indicator may represent a condition previous to the clearing and drainage for agriculture.

When walking the site, consider the potential animal impacts that may affect seedling survival and growth. The agricultural field looks like a wildlife wasteland now but, after tree planting, may quickly be colonized by animals such as beavers, nutria, feral hogs, rabbits, and deer. Beavers may dam drainage channels, inundating areas that had been determined as relatively dry. Always remember that even seedlings of flood-tolerant tree species will be adversely affected by long-term flooding or soil saturation.

Do not hesitate to establish a friendly relationship with the local residents. Ask the current farmer or adjacent landowners about flooding hot spots or soil problems on the site. These people may be your best source of information about groundwater influences, since many of them have recently drilled water wells on their property. Ask the farmer about the pesticides and mineral fertilizers used to grow the crops in the target and adjacent fields. Aerial applications of pesticides are used for many of the agricultural fields in the Mississippi Delta. Be aware that herbicide drift from adjacent agricultural fields may adversely affect seedling survival and growth. Unfortunately, there are probably few options to prevent this damage. One would be to convince the adjacent farmers to switch to a ground-based application system. A friendly relationship with the local residents could lead to a wealth of information about the site. Also, they may be more willing to help a familiar face in case of an emergency.

Field work should include selecting a BLH wetland reference site near the restoration site. With the high loss of BLH wetlands, this may be easier said than done. As best as possible, choose a reference site with similar soils, topography, and hydrology as the restoration site. In the Mississippi Delta, a common soil series association is the Dundee, Forestdale, and Sharkey catena. It would not be uncommon for the restoration site and a nearby forested site to be represented by this catena. During your walk-through, note the tree species located on each soil type. Consult the literature for the flood tolerance of the species observed (Table 1). The list created will be a good starting point in determining the desired tree species to plant and their location within the restoration site.

Because the wet agricultural fields usually have extensive alterations in hydrology, a temptation exists to plant tree species in locations where they would not be found in undisturbed conditions. A research study conducted at the Corp's Lake George Bottomland Hardwood Wildlife/Wetland Restoration Site, Mississippi, suggests that the natural tree species and soils relationships exist, despite the significant flood prevention activity on the site. The study consisted of planting Nuttall oak (*Ouercus nuttallii*, Palmer), water oak (*Ouercus nigra*, L.) and cherrybark oak seedlings on a Dundee, Forestdale, and Sharkey soil series. Nuttall oak, water oak, and cherrybark oak are moderately flood tolerant, weakly flood tolerant, and flood intolerant, respectively. The Forestdale and Sharkey soil series are hydric soils prone to long-term flooding or soil saturation, while the Dundee soil is a nonhydric soil. The hydrology on the study site is influenced by several large drainage channels. Nuttall oak had high first-year survival on all three soil series (Table 2). Water oak had lower survival than the Nuttall oak, but it was comparable on all three soil types. The flood-intolerant cherrybark oak performed poorly on the hydric

Table 1
Relative Flood Tolerance of Selected Bottomland Hardwood Tree Species Planted on Restoration Sites[1]

Common Name	Scientific Name	Flood Tolerance[2]
Green ash	*Fraxinus pennsylvanica*	Moderate
River birch	*Betula nigra*	Moderate
Eastern cottonwood	*Populus deltoides*	Moderate to weak
Baldcypress	*Taxodium distichum*	Tolerant
Water elm	*Planera aquatica*	Tolerant
Sweetgum	*Liquidambar styraciflua*	Moderate
Black tupelo	*Nyssa sylvatica* var. *sylvatica*	Weak
Swamp tupelo	*Nyssa sylvatica* var. *biflora*	Tolerant
Water tupelo	*Nyssa aquatica*	Tolerant
Sugarberry	*Celtis laevigata*	Moderate
Water hickory	*Carya aquatica*	Moderate
Shellbark hickory	*Carya laciniosa*	Weak
Red maple	*Acer rubrum*	Moderate
Cheerybark oak	*Quercus pagoda*	Weak to intolerant
Laurel oak	*Quercus laurifolia*	Moderate to weak
Live oak	*Quercus virginiana*	Weak to intolerant
Nuttall oak	*Quercus nuttallii*	Moderate
Overcup oak	*Quercus lyrata*	Moderate
Pin oak	*Quercus palustris*	Moderate
Shumard oak	*Quercus shumardii*	Weak
Swamp chestnut oak	*Quercus michauxii*	Weak
Water oak	*Quercus nigra*	Weak to moderate
Willow oak	*Quercus phellos*	Weak to moderate
Persimmon	*Diospyros virginiana*	Moderate
American sycamore	*Platanus occidentalis*	Moderate
Black willow	*Salix nigra*	Tolerant
Yellow-poplar	*Liriodendron tulipifera*	Intolerant

[1] Adapted from McKnight and others (1981).
[2] Tolerant = Species able to survive and grow on sites in which soil is saturated or flooded for long, indefinite periods during the growing season.
Moderate = Species able to survive and grow on sites in which soil is saturated or flooded for several months during the growing season, but high mortality can be expected if flooding persists or reoccurs consecutively for several years.
Weak = Species able to survive and grow on sites in which soil is saturated or flooded for relatively short periods during the growing season.
Intolerant = Species that are not able to survive even short periods of soil saturation or flooding.

Table 2
First-Year Survival by Species and Soil Series for the Lake George, MS, Study

Tree Species	First-Year Survival (Dundee Forestdale Sharkey), percent		
Cherrybark oak	91	53	50
Water oak	65	57	71
Nuttall oak	99	97	94

soils despite the potential for enhanced drainage by the drainage channels. The ponding or soil saturation caused by rainfall in the slowly permeable Sharkey and Forestdale soils may be sufficient to create anaerobic conditions detrimental to the root systems of cherrybark and water oak.

CONCLUSIONS: Other questions regarding the BLH wetland reforestation effort that remain to be answered include species availability, planting stock type, planting schedules, delivery and storage concerns, and planting methods. Literature is available to help in the overall planning of a BLH wetland restoration project (Allen and Kennedy 1989, Kusler and Kentula 1990, Hammer 1992, Allen 1993, Davis 1993).

A thorough knowledge of the BLH wetland restoration site and the flood tolerance of the endemic tree species will aid in successfully matching the right species to a particular location.

REFERENCES:

Allen, J. A., and Kennedy, H. E., Jr. (1989). "Bottomland hardwood reforestation in the Lower Mississippi Valley," USDA Fish and Wildlife Service and USDA Forest Service Bulletin.

Allen, H. H. (1993). "Basic considerations for vegetative design of wetlands," WRP Technical Note VN-EM-3.2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Davis, M. M. (1993). "Baseline site assessments for wetland vegetation establishment," WRP Technical Note VN-EV-2.1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Hammer, D. A. (1992). *Creating freshwater wetlands.* Lewis Publishers, Chelsea, MI.

Kusler, J. A., and Kentula, M. E. (1990). *Wetland creation and restoration: The status of the science.* Island Press, Washington, DC.

McKnight, J. S., Hook, D. D., Langdon, O. G., and Johnson, R. L. (1981). "Flood tolerance and related characteristics of trees of the bottomland forests of the southern United States." *Wetlands of bottomland hardwood forests; Proceedings of a workshop.* Lake Lanier, GA, June 1-5, 1980. J. R. Clark and J. Benforado, ed. Elsevier Scientific Publishing, New York, 29-68.

POINTS OF CONTACT:

Dr. Hans M. Williams, College of Forestry, P.0. Box 6109, SFA Station, Stephen F. Austin State University, Nacogdoches, TX 75962-6109, phone: (409) 568-2127, author.

Ms. Barbara A. Kleiss, U.S. Geological Survey, 308 S. Airport Road, Pearl, MS 39208-6649, phone: (601) 965-4600, co-author.